Research Project for Senior Fellowship in Urban Studies

Baltimore City Brownfields – GIS approach

Alexandru R Sandu – August 2000

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A very special thought is for Jason Byrne – the Aussie who eats koalas for dinner. He was, is and will be my best friend, with whom I shared ideeas about brownfields, environmental injustice, team concept, capuccinos at the Eisenhower Library and of course about our common lifestyle: surfing.

My sincere thanks to all the friends from US who helped and assisted me to live and understand the "New World."

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EXECUTIVE SUMMARY

This paper examines the policy-role of GIS tool in addressing the Brownfields sites in Baltimore City. The research was undertaken as a component of a Senior Research Fellowship through the Institute for Policy Studies at John Hopkins University in Baltimore, United States of America. The project, which is outlined in detail below, demonstrates that "power" and the necessity of the GIS as policy maker tool to urban policy, both in Baltimore and internationally. It demonstrates that the environmental and socio-economic objectives can be incorporated into policy and planning decision-making.

My research includes this paper and the GIS ArcView database on CD-Rom.

CHAPTER 1 - INTRODUCTION

The following paper discusses my work in developing a database GIS into industrial reuse in urban renewal projects in Baltimore City.

Environmental indicators, socio-economic, demographic and health indicators, which have a spatial distribution, are compared and contrasted. Using mapping techniques and spatial statistics, the environmental agencies can increase their capacity to consider the public redevelopment associated with different planning scenarios, set priorities for Brownfield redevelopment activities, and tracking pollutant concentration over the limits to success in reducing community-level risk factors.

Using GIS and mapping such indicators can provide the baseline for subsequent trend evaluations and sound environmental decision-making.

Structure of the paper

The paper commences with an overview of "Brownfield" issues and theory. Chapter 2 provides discussion of some case studies in Baltimore. Considerations are given to the disproportionate impacts of pollution.

The research design for the empirical research is discussed in Chapter 3. The relative merits of research methodologies are explored and the detailed aspects of qualitative and quantitative methodologies used throughout the research are discussed.

The fourth chapter of the paper is dedicated to analysis of the empirical and demographic data. This chapter will analyse the obtained data by tables looking to the quantitative aspects provided by these maps. Socio-spatial demography of pollution in the city is compared in this chapter.

The fifth chapter is dedicated to conclusions.

Role of Environmental Regulations in Impeding Brownfields Redevelopment

Metropolitan areas of the United States have been experiencing economic decline for some time. Both shifts in economic activity from urban areas to suburban locations, and inter-regional migration from the Northeast and Midwest to the South and West have contributed to this decline. These demographic shifts, along with the overall trend away from heavy industry and other types of manufacturing, have left many old industrial areas idle, under utilized or completely abandoned (Brownfield sites). Information on the costs and benefits of redeveloping Brownfield sites is needed to set priorities and develop effective strategies that will ensure the success of Brownfield redevelopment projects.

Many of the old industrial sites in Baltimore have been abandoned, causing Baltimore to lose over 50% of its manufacturing jobs between 1970 and 1990. The threat of contamination

and liability of these sites has inhibited reuse and redevelopment. The city estimated that 3500 to 5500 acres of land zoned for heavy manufacturing contains environmental problems that impede their marketability.

Hazardous waste regulations, both federal (CERCLA) and state, present difficult barriers to economic redevelopment, because of the financial uncertainties that developers and other associated parties (e.g., lenders) face due to potential Superfund liability and duration of time. Usually to become a Superfund site it is the last solution wondered by the developers, once a site gets involved in Superfund, "it'll be years and years before anything happens" (Evans Paul, BDC, statement).

The stringency of EPA Superfund clean-up standards is often cited as a major impediment to the clean-up and redevelopment of Brownfield sites. However, Superfund standards are perceived as inappropriate for many Brownfield sites that are not, or may not be, seriously contaminated and where human and environmental exposure can be limited through various mechanisms. Yet, CERCLA and the Superfund program as implemented provide little or no flexibility to set alternative clean-up standards based on reasonable distinctions among the levels of risk at each site (i.e., based upon the severity of the contamination, fate and effects information, and the likelihood of human or environmental exposure to the contamination).

It is difficult to determine the extent to which CERCLA, by itself, impedes development of Brownfield sites. Other factors associated with urban economic decline are also likely to hinder Brownfield development. Previous studies suggest that while liability concerns associated with CERCLA may impede development, they are unlikely to be the major cause of distressed real estate markets in old industrial areas.

Other factors, such as proximity to skilled labour and major transportation routes, crime rates, and local tax structure, are likely to concern developers largely. The factors that motivate land development are complex, and the contribution of each of these factors to the Brownfield development problem is unknown and likely to vary from one property to another.

Policy issue

The interplay between the economic and the environmental arenas has dominated community development strategies in countless jurisdictions across the country. Acquiring, cleaning, and redeveloping older, and often abandoned, industrial sites can be very expensive and time consuming. In many situations, private developers and financiers are not able, or willing, to act on their own to ensure that the full economic potential of site reuse will be achieved. Rightly or wrongly, the ambiguity of statutes governing liability and cleanup has increased the uncertainties and perceived problems associated with Brownfield activities. Judicious concern over environmental problems has brought a new dimension to the risks that lenders face and the obstacles that developers and local agencies must surmount.

There is strong evidence to suggest that, there is an urgent need for the development of policy approaches, based on defendable empirical research, to address issues of environmental redevelopment brownfields in the design and redevelopment of urban areas, particularly those

characterized by undesirable land uses. Problems that have arisen by not taking these issues into account include the exposure of people and low-income earners to health hazards such as toxic chemicals, radiation, lead, and air and water pollution.

Policy significance of the topic

The term "Brownfield" can include previously-undeveloped land, for example, if use or development is deterred because the property is believed to be contaminated because it is adjacent to a contaminated property or it is believed to be the site of improper pollutant dumping.

The term "*Brownfield*" should include any site (whether urban or rural, industrial or non-industrial and whether abandoned, idled, under-used, or previously undeveloped) at which the timely use, expansion of the current usage, or redevelopment of the site is prevented by real or suspected environmental contamination regardless of the actual severity of any contamination. The term "*Brownfield*" became a stigma for the sites called like that, impeding their clean-up and redevelopment.

The topic is extremely relevant both to Baltimore and cross United States of America. The most immediately noticeable characteristics of inner city Baltimore are the virtually incessant sound of the sirens of emergency vehicles. The pollution is a legacy of the city's industrial heritage and a product of thousands of commuters as they stream to and from the suburbs in a ritualised diurnal exodus.

Furthermore, the unemployment rate of Baltimore is currently at 10.7%[1], which is considerably greater than the national average. Land use planning solutions to reversing declining populations, unemployment and crime in this old industrial city, Baltimore, have traditionally focused on economic approaches, particularly the revitalization of blighted inner city areas. Baltimore's port district, with its US$650 million marina and condo tower development is one such example[2]. The development of the world trade center and more recently, the transformation of the old industrial site at Canton into condo towers, townhouses, offices and restaurants are other good examples. However, these measures often damage the very people who had been worst affected by the economic structural change – people of colour and other low-income earners. These are vulnerable communities. They have been forced to live in the most blighted and often most contaminated areas the city, something that is frequently detrimental to their health. Then they suffer social and economic hardship when these areas are redeveloped[3].

GIS "power"

As shown in Figure 1-1, the concept of GIS information is intended to integrate economic, environmental, and social factors, thus guiding Brownfield redevelopment strategies in a way that achieves the multiple objectives of:

[1] Internet information from the Department of Economic and Employment Development, Office of Labour Market Analysis.
[2] Information derived from by the Baltimore Chamber of Commerce Internet site.
[3] Jason Byrne, "Green Around the Gills – Environment, Justice and the Inner City", December 2000.

- Generating investment in urban areas which ultimately provides increased tax revenues and jobs,
- Reducing human health and environmental risk, and
- Benefiting low income and minority populations by revitalizing their neighbourhoods.

Figure 1. GIS concept

Social Factors

Those associated with benefiting low income and minority populations

GIS

Targeting Successful Brownfield Redevelopment

Environmental Factors

Those related to human health and environmental benefits

Economic Factors

Those affecting the generation of business, tax revenues, and jobs

Applying the **GIS** concept will identify urban properties that have the most redevelopment potential and the greatest economic, environmental, and social benefits. It will also identify the

costs and benefits of Brownfield redevelopment, as well as impediments to successful redevelopment from both the community and developer perspectives. In doing so, the general GIS can be used as a tool to set priorities for redevelopment projects, target economic development incentives and programs, and develop strategies for Brownfield site redevelopment.

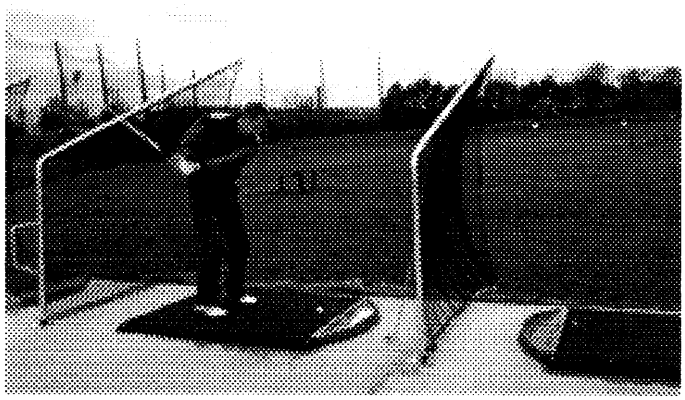
CHAPTER 2 - "Lessons Learned" about Brownfields Cleanup and Redevelopment in Baltimore City

There are some sites in Baltimore declared "***Superfund***" sites, as The Chemical Metals Industries, Kane & Lombard Street Drums and 68th Street Dump/Industrial Enterprises, which was cleaned-up and developed or due to the big period of time they are in the second phase as CMI and 68th St DIE.

Kane & Lombard Street

The oldest, the 10-acre Kane & Lombard Street Drums Site in Baltimore, Maryland was part of an open dump where demolition, municipal, and industrial wastes were disposed of between 1962 and 1984. This site was proposed to the National Priorities List of the most serious uncontrolled or abandoned hazardous waste sites requiring long-term remedial action on October 1, 1984 and was formally added to the list June 1, 1986, making it eligible for federal cleanup funds. The ground water beneath and in the vicinity of the Site is contaminated with volatile organic compounds (VOCs), including trichloroethene, 1,2-dichloroethene and vinyl chloride, and metals, including cadmium, lead, manganese and nickel, as a result of past waste disposal practices. The City of Baltimore supplies drinking water to area residents and no residential wells are known to exist within a half-mile radius of the Site. There is a potential for contaminated ground water at the Site to affect nearby production wells. The clean-up was done by 1,200 drums removal, many of which contained flammable solids. The site was covered with topsoil and installed a fence to limit the access.

This site was transformed into a golf place.



In 1990, EPA completed construction of a subsurface barrier wall that encloses the waste disposal area and a permanent cap in order to prevent further releases of contaminants into ground water and to eliminate the potential for exposure to contaminated soils. In July of 1993, four potentially responsible parties (PRPs) signed an Administrative Order on Consent with EPA, which requires the PRPs to determine the nature and extent of ground water contamination that has resulted from releases at the Site and additional properties immediately north of the Site. This investigation will identify alternatives for addressing the contamination and is scheduled to be complete by the summer of 2000.

The massive publicity about some states brownfield programs give the impression of thousands of sites being redeveloped. Detailed analysis of the composition of cleanups in state

VCPs, however, reveals that for-profit reuses of previous underutilized sites amount of 8-20% of the projects entering the programs[1].

The ***Voluntary Cleanup Program***, which is administered by the Maryland Department of the Environment (MDE), streamlines the environmental cleanup process for sites contaminated or perceived to be contaminated by hazardous substances. Often these sites are abandoned or under-utilised industrial or commercial properties. The site is eligible for the VCP unless it is: on the National Priorities List (NPL), under active enforcement by MDE, subject to a state – controlled hazardous substance permit or contaminated after October 1, 1997 and owned or operated by a party responsible for the contamination. This means that all the sites, which were on the NPL, cannot obtain this help as VCP.

In Baltimore City, MDE has in process around 24 VCPs applicants, to August 2000.

Can Company

Among them, Can Company, one of the most successfully brownfield redevelopment had a good redevelopment. The property has been redeveloped into an office-retail complex. Between 1895 and 1986, the plant produced finished metal cans from coils of metal stacks and generated industrial waste such as chrome solution, lead dross and organic solvents.

In the 1980s, two 500-gallon aboveground gasoline storage tanks were removed. Two other areas of environmental concerns at the site, addressed in 1988, were a concrete containment area filled with petroleum contaminated soil and the former location of a 2,000-gallon underground storage tank.

On July 5, 1989, MDE's Toxic Environmental Science and Health (TESH), Toxics Operations Program, was alerted to a polychlorinated biphenyl (PCB) spill by a contractor conducting asbestos removal on the site. Four vandalized transformers, located on the plant's second floor, leaked approximately ten gallons of PCB onto the first floor via a large steel mezzanine. Because PCB levels in the spill area exceeded the Toxic Substances Control Act regulatory limits, MDE/TESH notified the U.S. Coast Guard National Response Center and mobilized a remedial contractor to contain and remediate the spill. Cleanup fluid comprising a 50% mixture of penetone and water, material from the spill, and PCB fluids drained from the four vandalized transformers were stored in two 55-gallon drums. Approximately 60 to 80 gallons of PCB contaminated material spread over the first and second floors. In response, MDE/TESH directed the remedial contractor to drain all PCB fluids from all twelve on-site transformers into twenty-five 55-gallon drums, and excavate contaminated PCB soil and concrete for disposal at an approved off-site facility.

In May 1991, MDE's Hazardous and Solid Waste Management Administration conducted an Environmental Priorities Initiative (EPI) Preliminary Assessment (PA) at the ANC site to address past disposal practices and current site conditions The contaminated areas outlined in the EPI/PA were cleaned up to State mandated standards and the contaminated waste disposed of by State certified hazardous waste contractors. In 1991, the U.S. Environmental Protection Agency (EPA), Region III, designated the site as "No Further Remedial Action Planned."

On May 15, 1997, the prospective purchaser of the property, The Can Company L.L.C., submitted an application to the VCP. MDE requested the collection of additional soil

and groundwater samples from former areas of operations. Analysis of subsurface samples, collected in June and July 1997, revealed arsenic, chromium, and elevated levels of lead in soil. The status of The Can Company L.L.C. as an inculpable person was approved on August 6, 1997. Ownership of the site was transferred to The Can Company L.L.C. on August 13, 1997. A proposed response action plan developed to address site contaminants was approved by MDE on October 23, 1997 and implemented on October 30, 1997. The work outlined in the response action plan was completed in April 1998.

Almost all the sites applicants at the MDE VCP's generated hazardous and nonhazardous wastes from their manufacturing processes or operations at the sites have involved the wholesale distribution of chemicals, organic solvents, and petroleum products. All these substances affected the environment being a threat to human health, socio-economic development, and environment.

MDE has records on all these sites inventoried, which applied to VCP and other sites non-declared yet "brownfield".

CHAPTER 3 – RESEARCH DESIGN

The project is based on a qualitative research methodology. Information from the 1990 Census, environmental data from MDE, BDC (Baltimore Development Corporation), health data[4], were collected and used in this research. Sources include historical records, newspaper articles, census data, government publications, community information brochures, books and journals.

Interviewers were done to perceive the merits of various policy solutions are. Land use planners and decision-makers were interviewed, to compare their views.

Colton (1990), Fitton (1992) and Beckwith (1996) who have compared the siting of hazardous waste facilities and racial and social economic characteristics, and Schlossberg (1995) discussed the merits of using GIS and census data to evaluate environmental inequity.

As tool, the ArcView GIS 3.2 program was used, including its basic data for Maryland, Baltimore City[5]. EPA web site was source for environmental data.

Working spatially

ArcView can be used by anyone who wants to work spatially. A key feature of ArcView is that it is easy to load tabular data, such as dBase files and data from database servers, into ArcView so that we can display, query, summarize, and organize this data geographically.

Here are some of the keys tasks can be accomplished with ArcView.

- Display geographic data on a view
- Make maps from existing spatial data sources.
- Display tabular data on a view
- Import tabular data and then join it to the data in a view to display it geographically. Overview of adding tabular data to a view
- Use SQL to retrieve records from a database and display them on a view
- connect to a database to get a tabular data and then work with it geographically.
- Geocode tables containing addresses and display them on a view

[4] Jonathan M. Samet and Sarah Adams, "Cancer Incidence and Mortality Patterns in Baltimore City", December 1999- Department of Epidemiology - School of Hygiene and Public Health - JHU

[5] James E. Gillispie, Milton Eisenhower Library, Johns Hopkins University.

Any tabular data containing the addresses of customers, suppliers, competitors, stores, offices, facilities, etc. can be displayed on a view as points or digitized as polygons. ArcView geocodes this data in order to add it to a view.

- Create and edit spatial data.
- Create your own spatial data to represent spatial features
- Find the attributes of any features on a view
- For example, you can summarize data for cities on a state or regional basis. You can also generate statistics about any attributes.
- Create custom ArcView applications for other people to use.

In my case, ArcView is a powerful tool to create brownfield database on GIS, which can be updated, transformed and creating overviews on the problem we want to follow, environmental, social, health, etc.

CHAPTER 4 - ANALYSIS

4.1 Race distribution

Table 1 shows that the racial distribution of Baltimore City in 1990 was 39% white, 59% black, and 2% other.

TABLE 1. RACIAL DISTRIBUTION IN BALTIMORE CITY, 1990 FROM US CENSUS BUREAU DATA

Race	Count	Percent of total
White	287,933	39
Black	435,619	59
other	12,462	2
total	736,014	100

Figure s 2 and 3 provide a demographic overview of Baltimore City in 1990 on the U.S. Census. The Figure s shows that the white population is grouped around the industrial zones, around the Inner Harbor in Fells Point, Canton, Camden, Federal Hill due to the former industry. The black population is grouped in area without industrial interest, the rest of the city less the Northeast.

For both races, the largest group falls between 25 and 44 years old, and there are smaller peaks in age categories 65-70 and older than 75 years. An evaluation of counts by race, age, and gender shows that females begin to outnumber males after 17 years for blacks and after 59 years for whites. Blacks outnumber whites until 65 years; thereafter, the pattern is reversed[4].

In my opinion, the data, maps are qualitative because the last 10 years changed the real situation, not very much but sufficiently to consider Census 1990 as qualitative information.

Figure 2. Percentage of White Population by Census track 1990

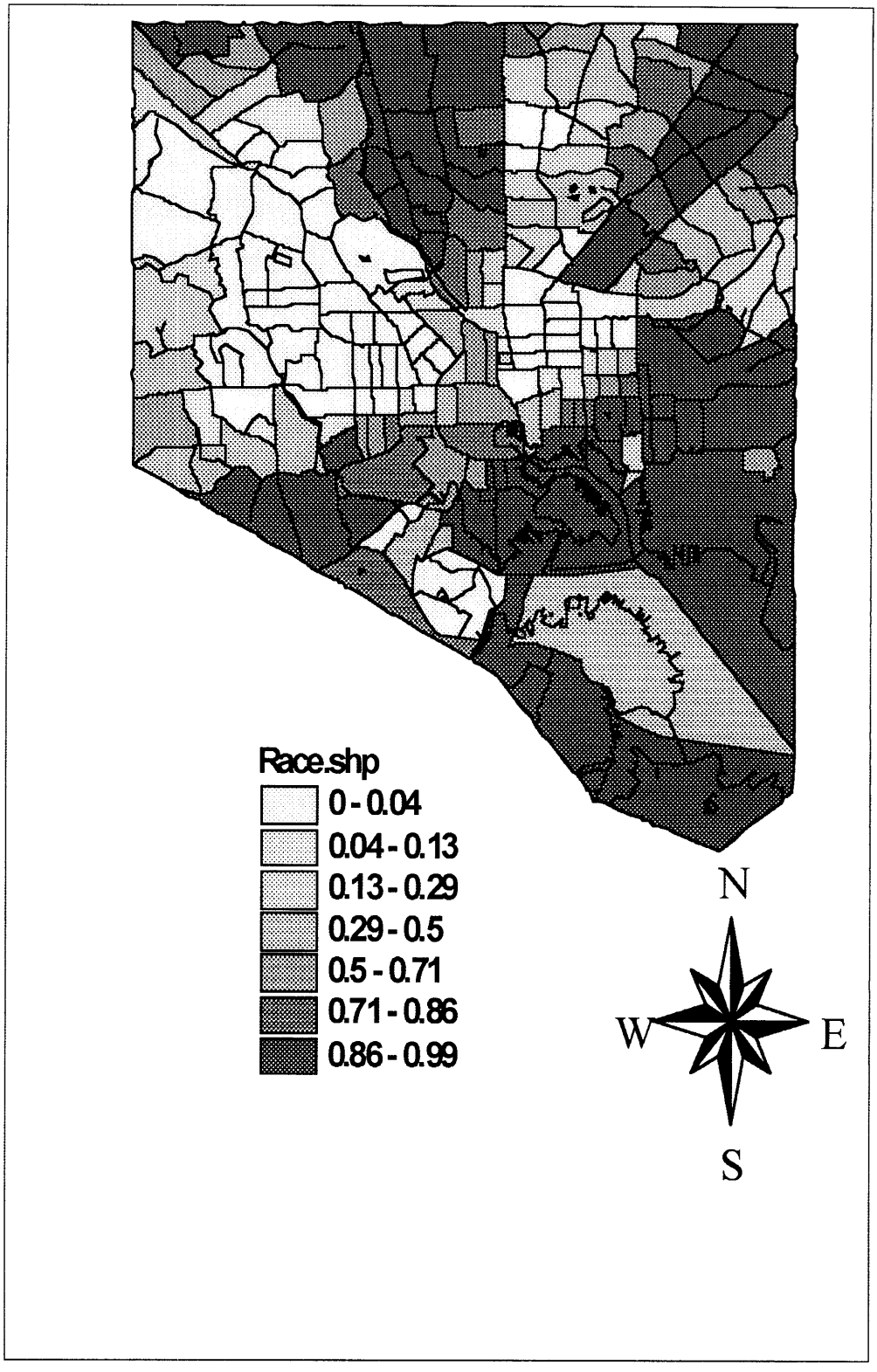
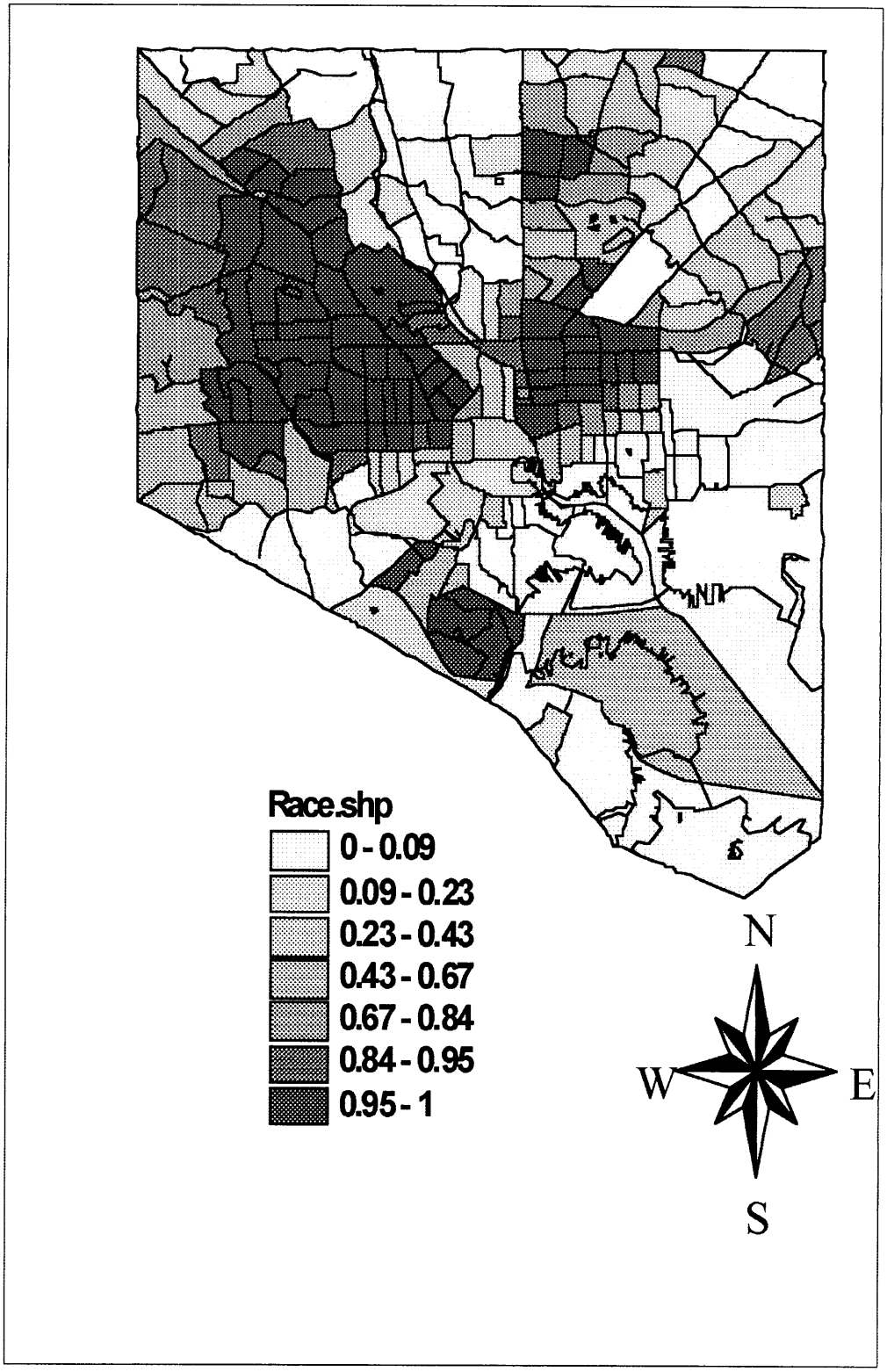


Figure 3. Percentage of Black Population by Census track 1990


Race.shp
0 - 0.09
0.09 - 0.23
0.23 - 0.43
0.43 - 0.67
0.67 - 0.84
0.84 - 0.95
0.95 - 1
N
W
E
S

4.2 Brownfields

The data will be presented in several categories provided by the different sources. The maps were built through the data collected from the sources named below.

Figure 4 shows Superfund sites and NNPL (sites which were before listed on National Priorities List and were taken out). These shape files, which generate the maps through ArcView, include details as name, address, EPA code, and geographical coordinates. There are 3 Superfund sites, among them only one is completed, Kane and Lombard St., described above in the chapter 2, the other are currently on clean-up status.

Figure 4. Superfund and NNPL sites – Baltimore City

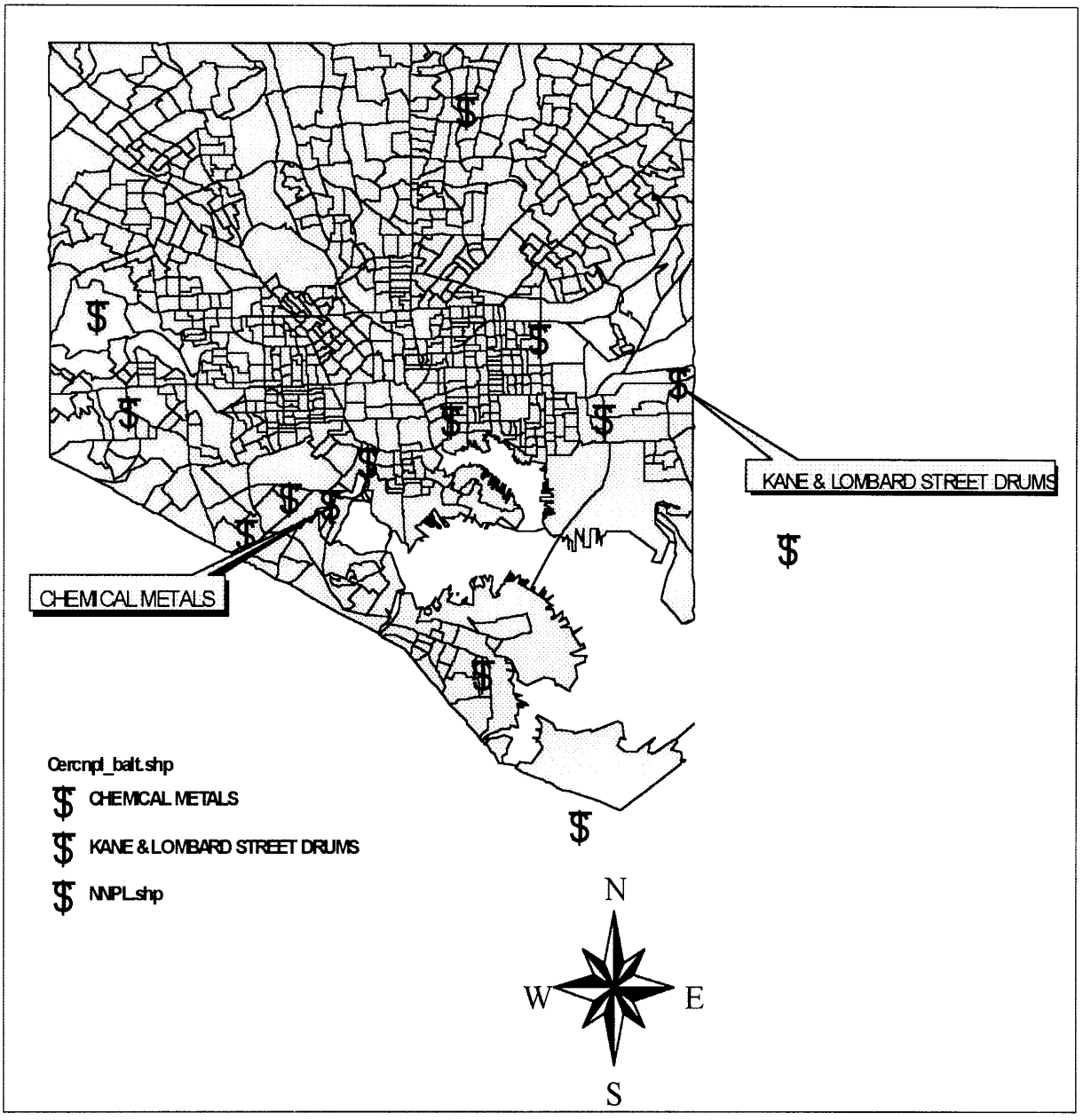
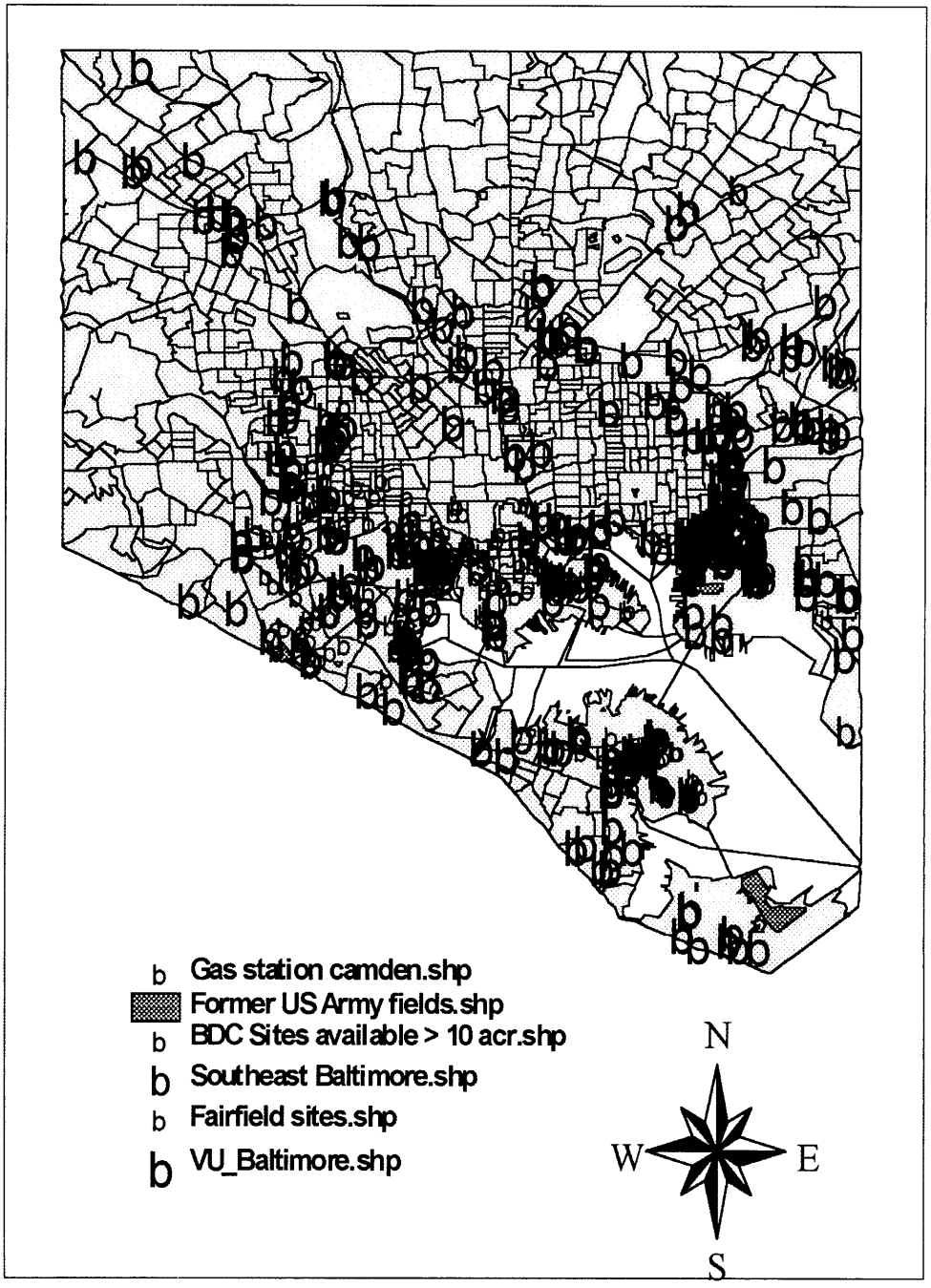


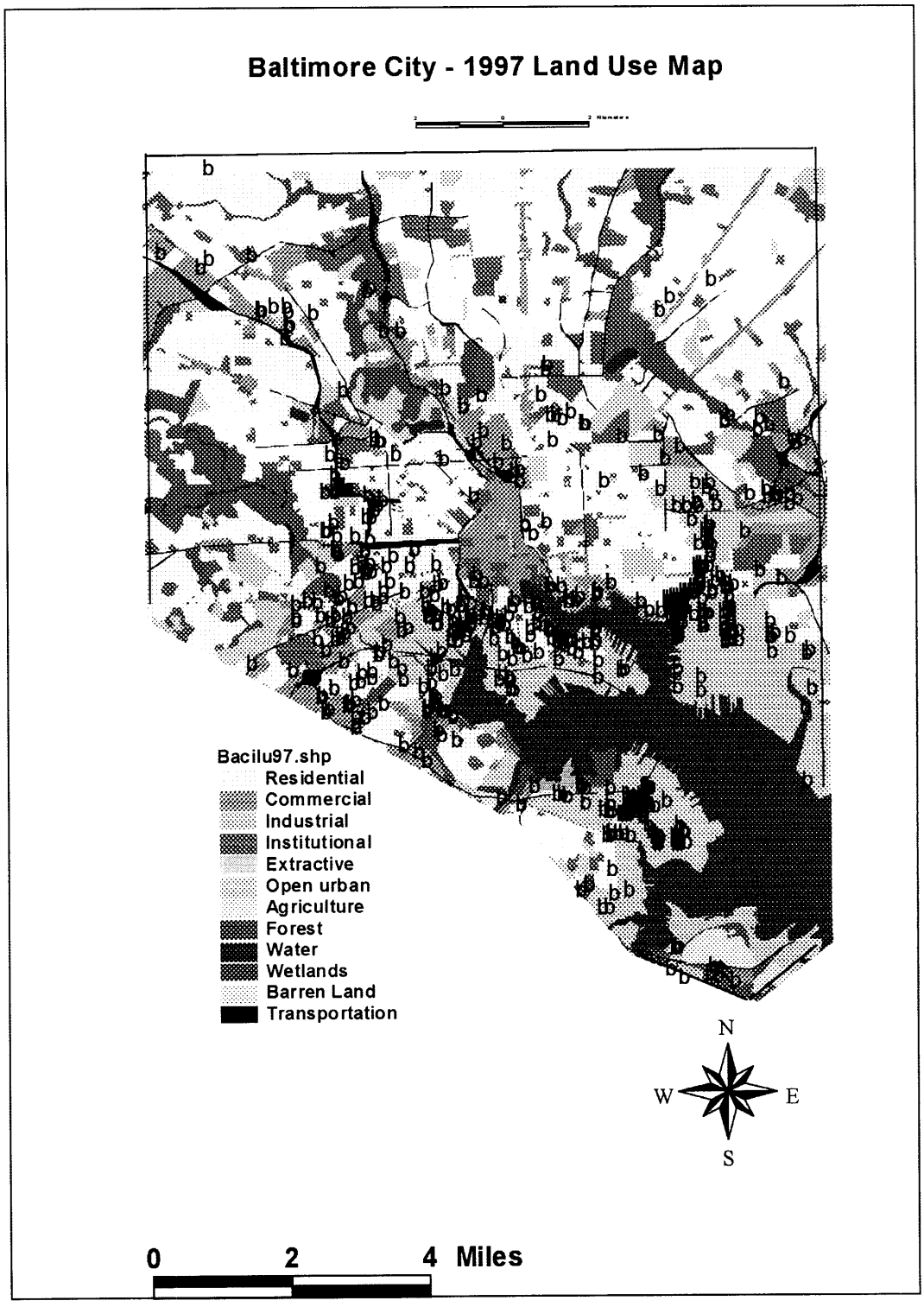
Figure 5 shows all the brownfields in Baltimore city, the shape files, which form this map are: Southeast, Fairfield[6], Camden, US Army former fields[7] and vu-Baltimore[8], it means more than 1000 sites presents in the "city of sirens". All these data were transformed and linked to the database for the Baltimore City.

Figure 5. Brownfields sites in Baltimore City



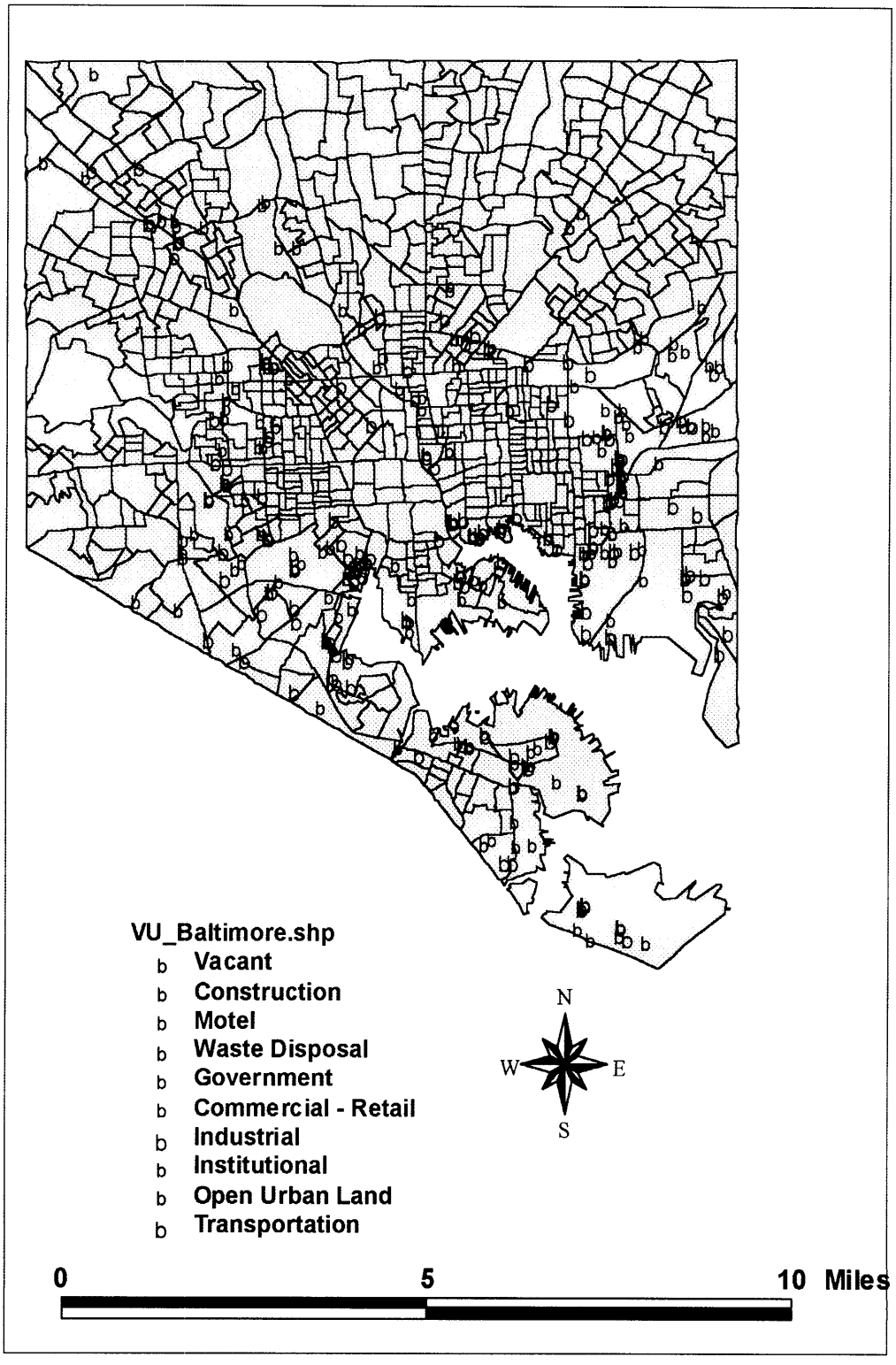
[6] Data provided by Miriam Shoenbraum, DOGEE – JHU, June 2000.
[7] Data provided by Ronald T. Santos, US Army, Corps of Engineers, Baltimore District.
[8] Data provided by Jill Litt, School of Public Health – JHU, June 2000.

Figure 6. Brownfields sites in land use map on Baltimore City 1997



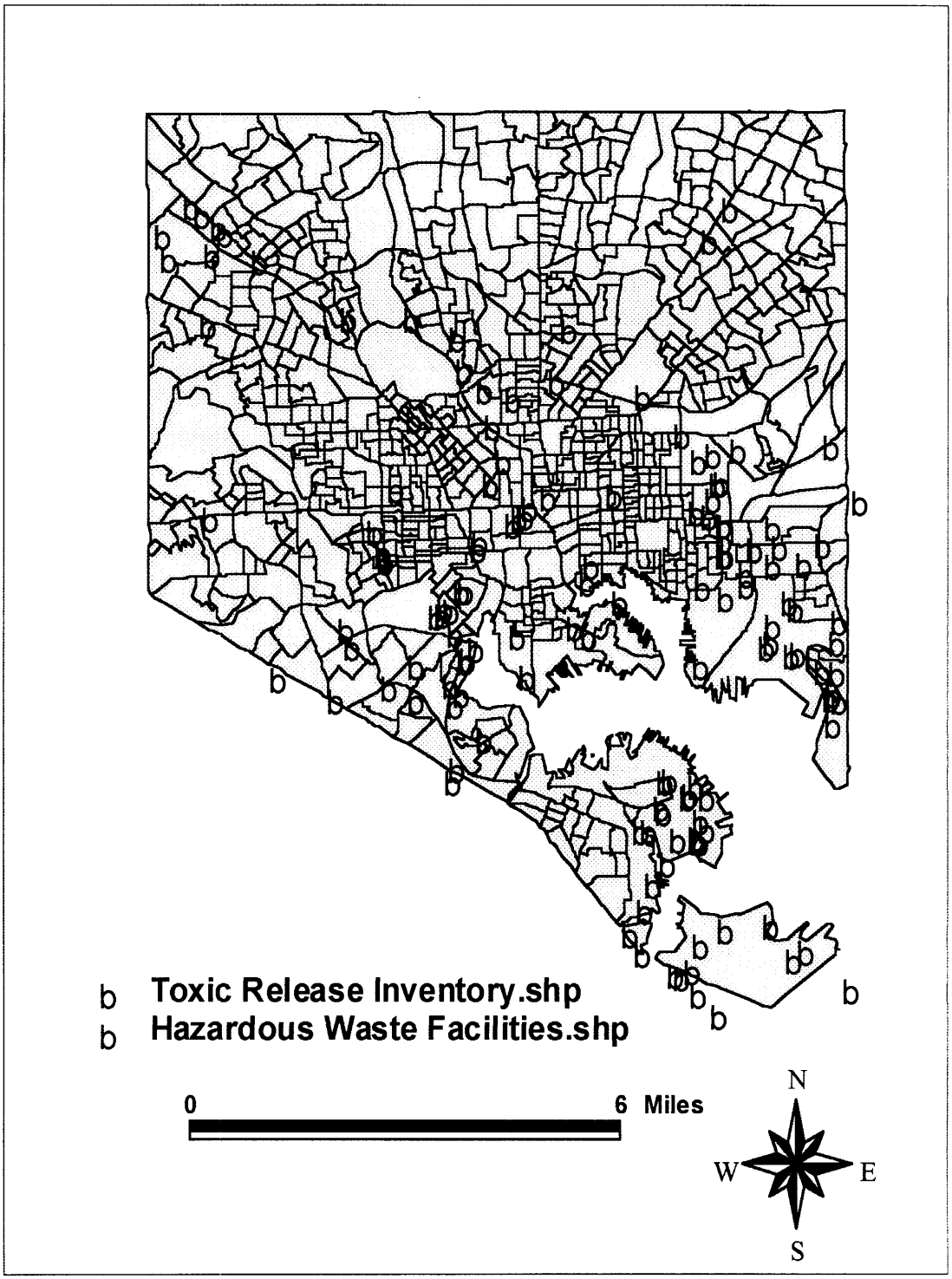
To complete and to have a better understanding on the spatial distribution of these stigma sites, "brownfields", the Figure 6 shows them related to the land use of 1997 in the city[9]. The map is highlighting the bigger number of the brownfields sites, in the industrial zone, around the inner harbor.

Figure 7. Sites use from VU_baltimore



[9] Maryland Office of Planning, Planning Data Services - 1997 Land Use/Land Cover for Maryland

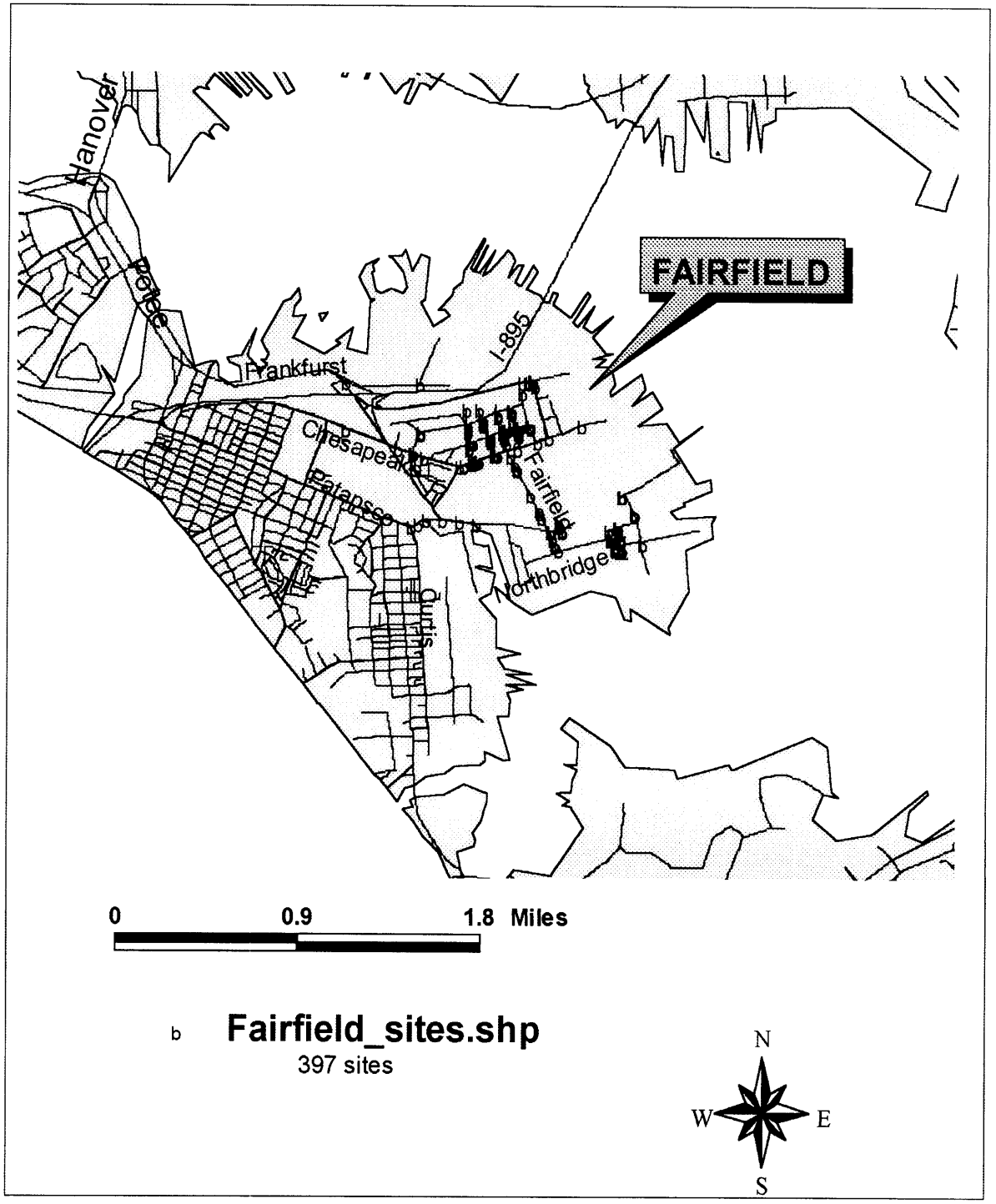
Figure 8. Hazardous waste facilities & toxic release inventory sites – EPA



The 8th Figure shows the hazardous waste facilities and the toxic release inventory registered by EPA in Baltimore City. These sites are potential hazardous waste producers, I have not found

during my research, complete information about them as pollutant track, etc. These sites should be surveyed and controlled if they frame the standards for their wastes.

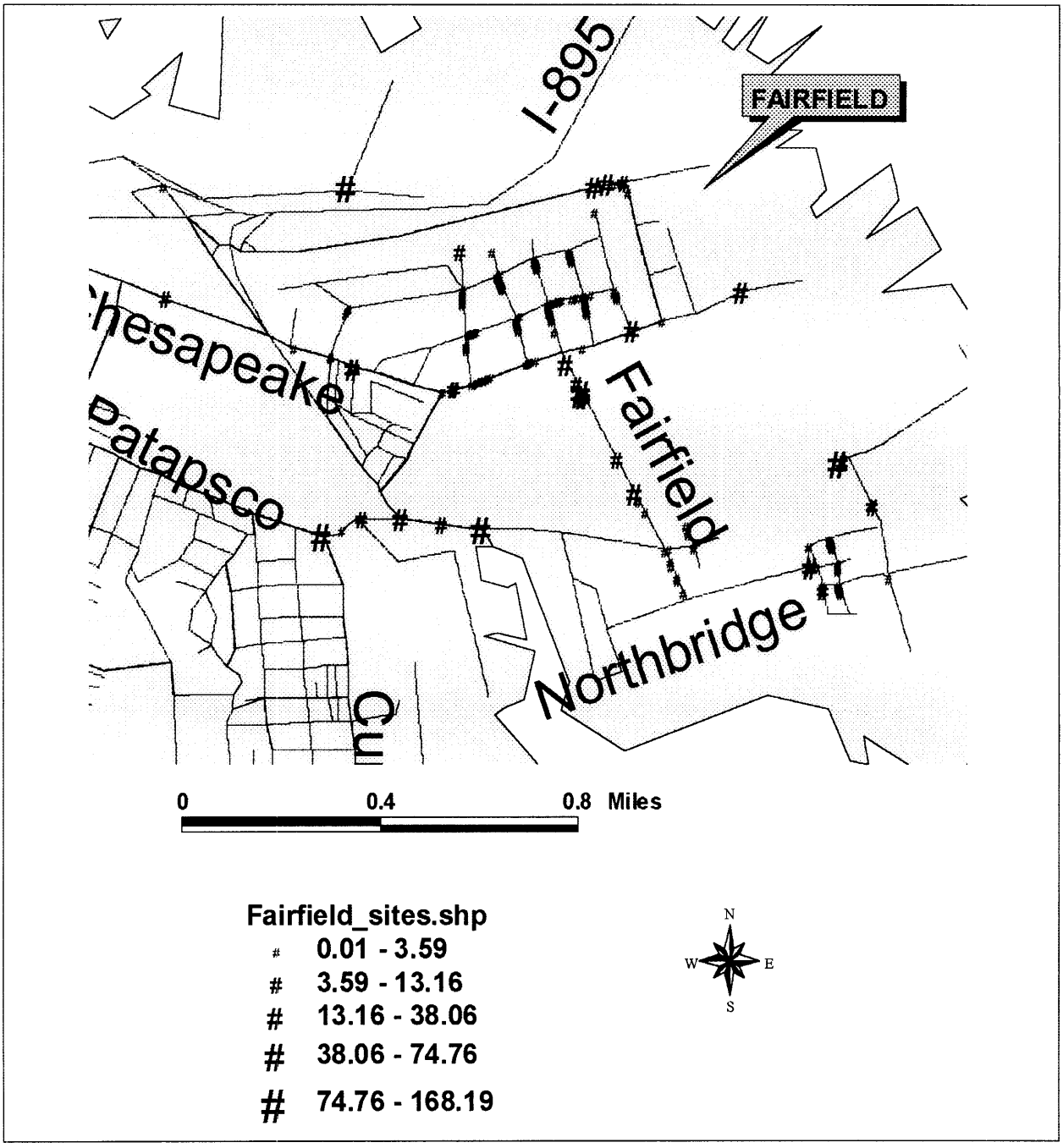
Figure 9. Brownfields in Fairfield



This shows the Fairfield's sites. Fairfield was one of the most fruitful industrial area in Baltimore up to 20 years ago. It has 397 sites inventoried. Among these sites most of them are chemical

manufacturing, port shipping, offices, junkyard (44 sites), petroleum, truck parking, waste disposal, residential (109), etc.

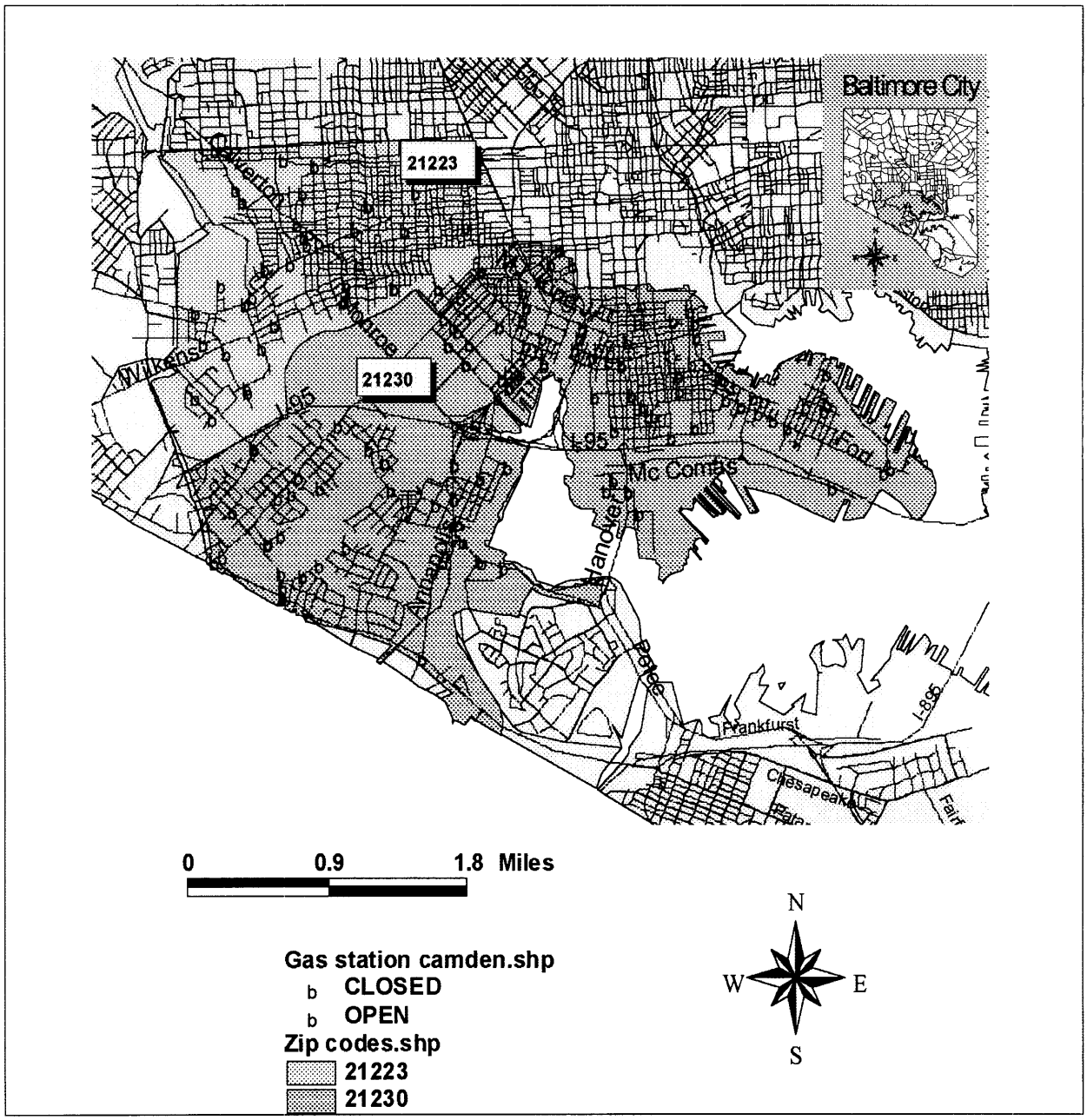
Figure 10. Brownfields in Fairfield



The available acreage in Fairfield is quite big. The surface is between 1 acre and 170 acres. Fairfield is a former fruitful industrial area in Baltimore. There is a big impact of the pollution to

environment and population. In the area there are no more than 400 people still leaving. There is no more manufacturing or other.

Figure 11. Gas stations in Camden



In Camden , 2 zip codes, there are 337 gas stations. 277 of them are closed , the rest of 60 still open. These gas stations were inventoried by MDE, looking forward to make soil tests and sample analysis to evaluate the environment impact.

4.3 Health parameters

Residents of Baltimore City, like people everywhere, are concerned about their health and fearful that their environment may contribute to ill health.

Figure 12. Cancer Incidence Rate – White population, 92 -95

Cancer Incidence Rates

Cancer is a particularly disease, both because it all too frequently leads to death and because people know that environmental factors can cause cancer, regardless of lifestyle and heredity. The following maps shows how the cancer incidence rate and mortality due to cancer vary across zip codes of the city.

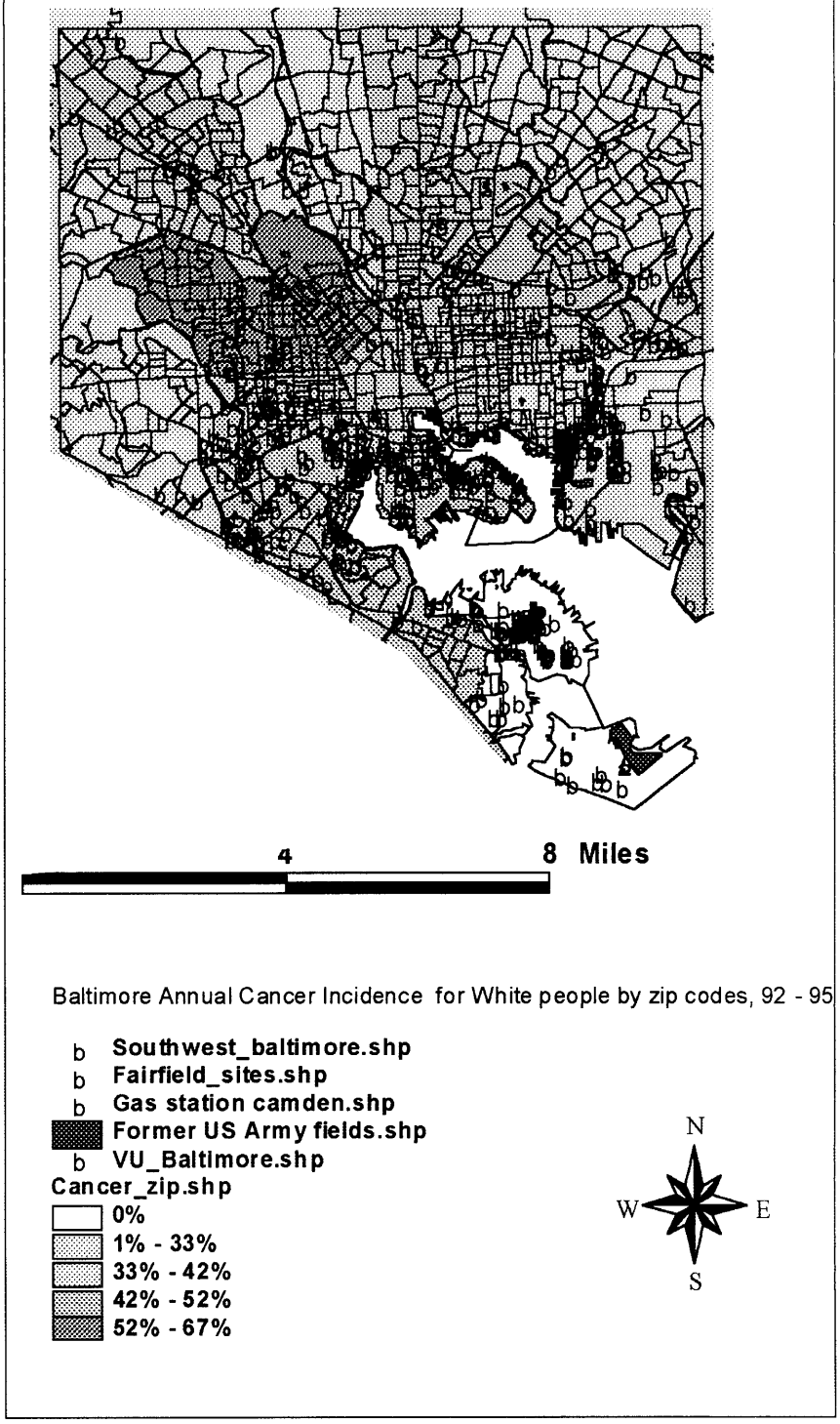


Figure 13. Cancer Incidence Rate – black population, 92 -95

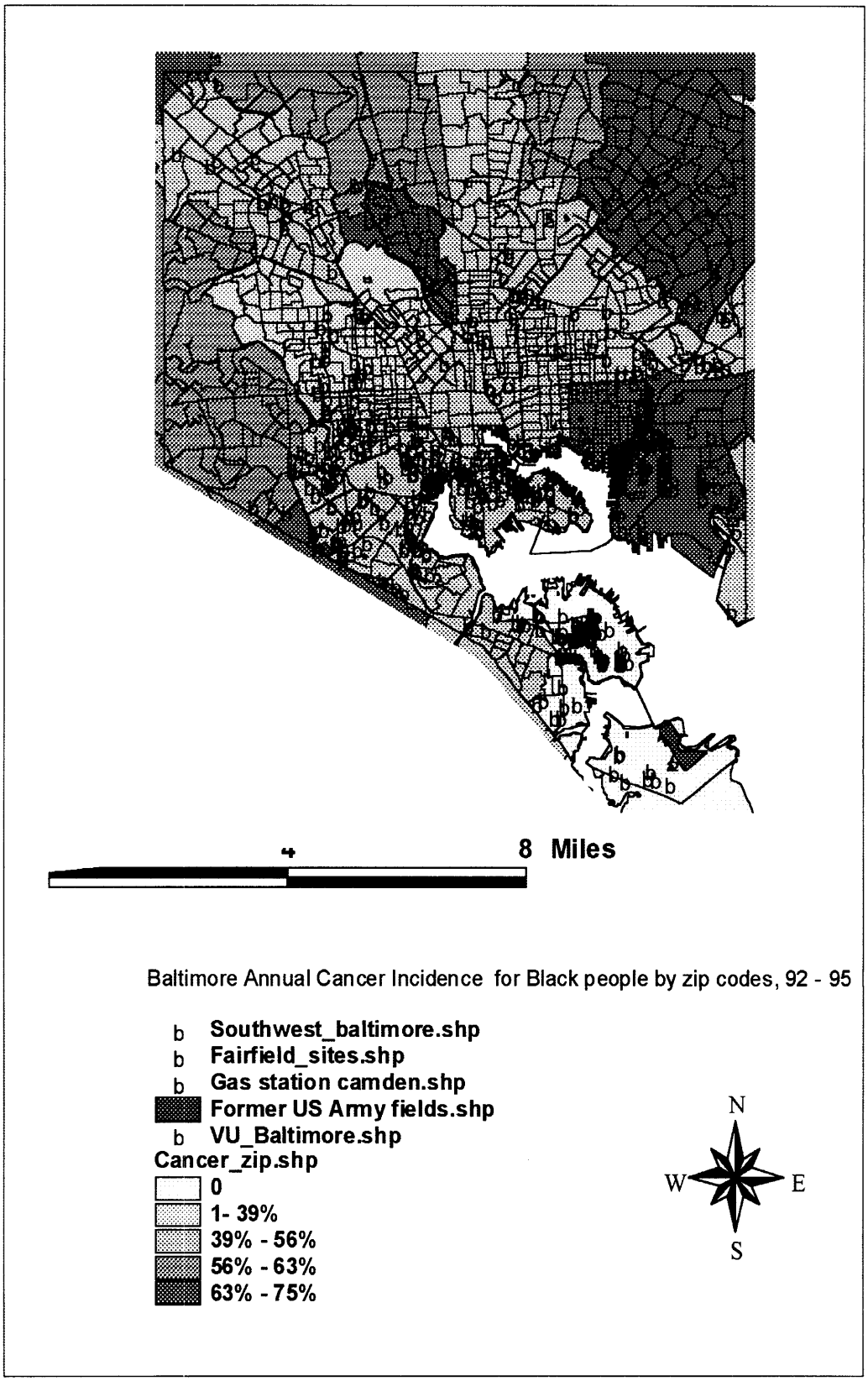
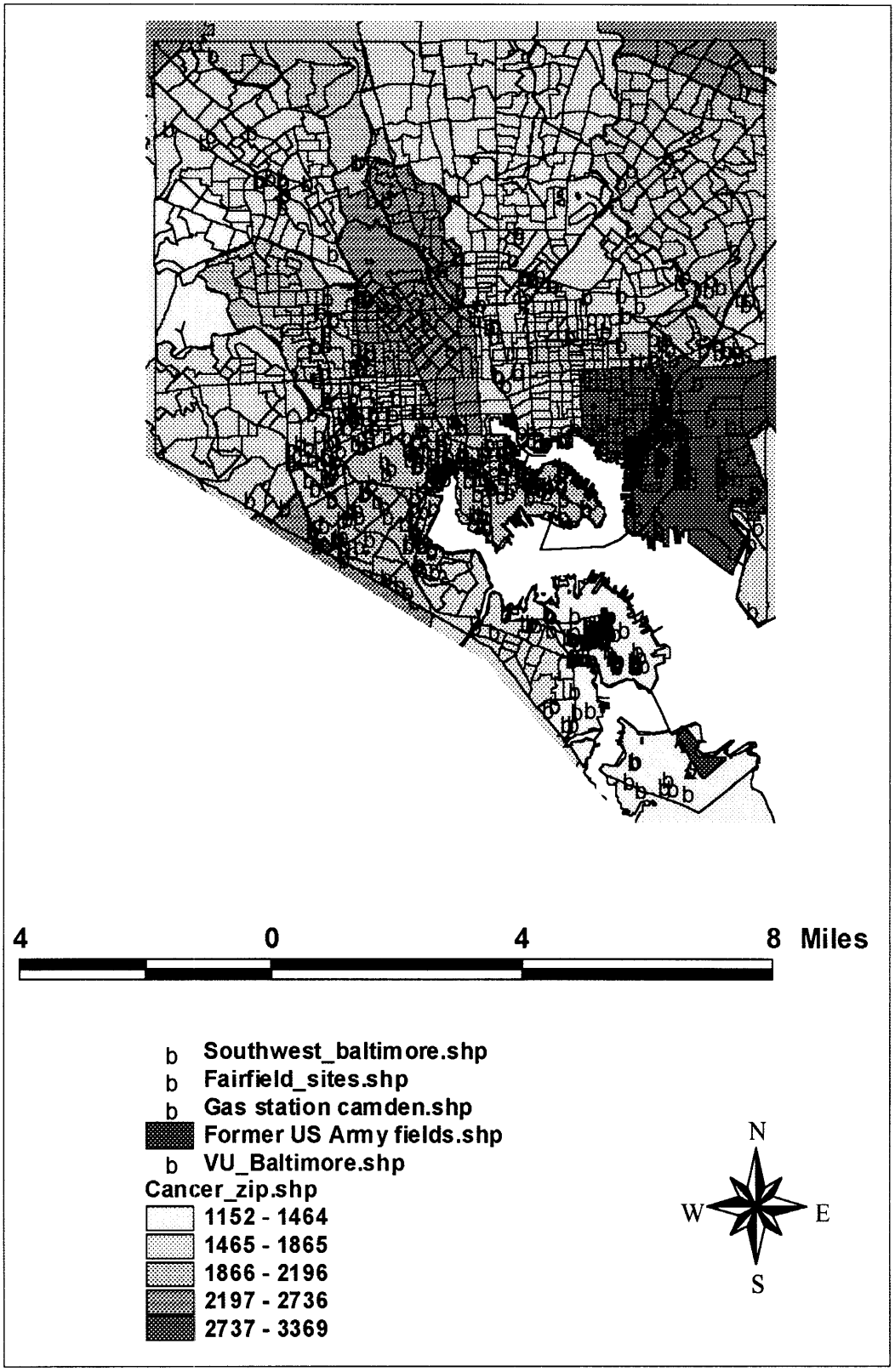


Figure 14. Cancer Incidence Rate – 92 –95



The rate for the black population is higher than for white group. The analysis confirm once

again, that Baltimore City has the higher cancer rates than the state of Maryland in general. For some zip codes, rates are well above those for the nation[10].

Mortality Rates

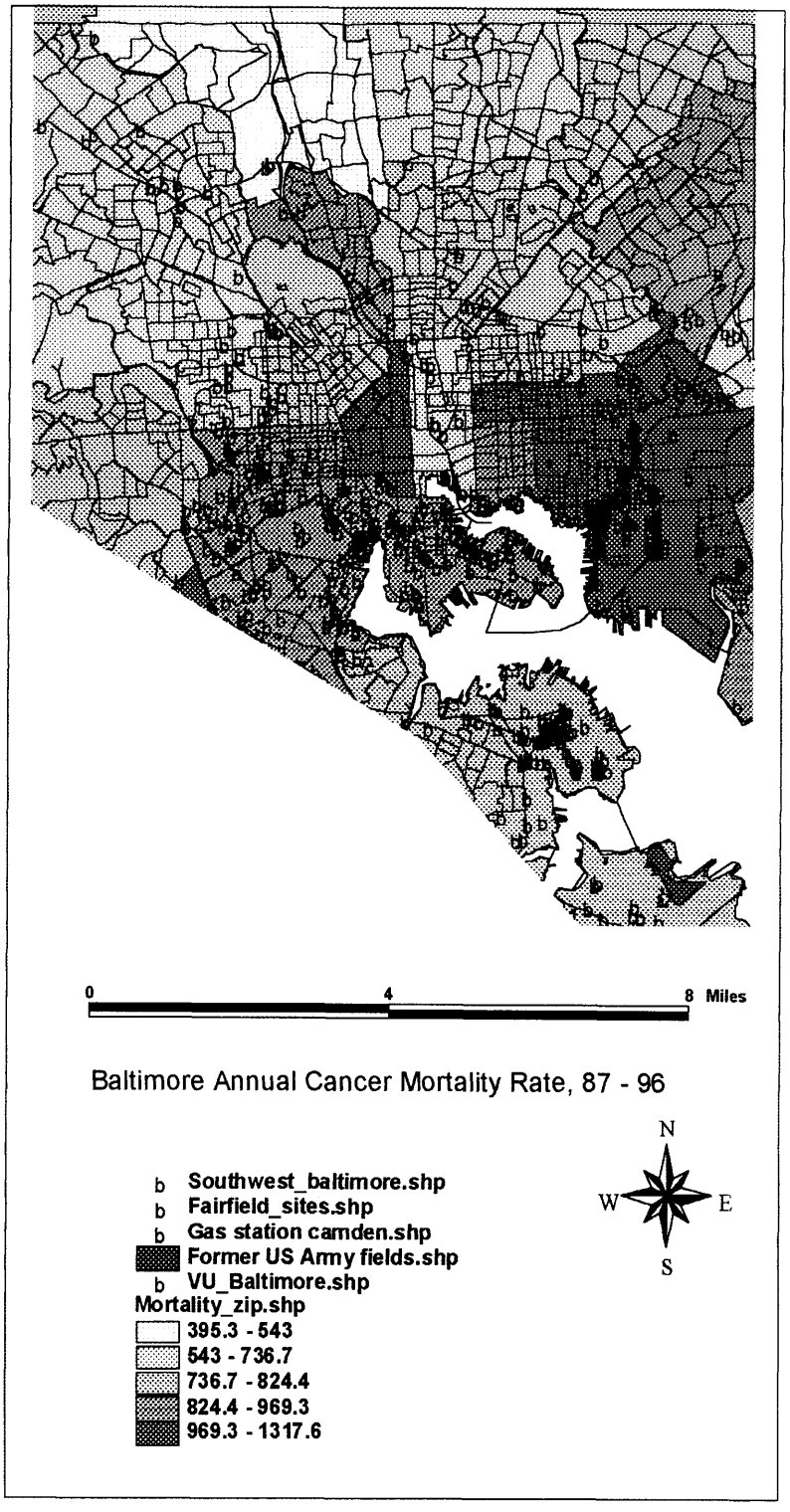
Mortality counts are substantially below incident cancer counts for most sites. In general rates for cancer mortality are more similar than were the incidence data, comparing Baltimore City to the US and Maryland[10].

The biggest rate is in Canton, the southeast of Baltimore City. This Figure shows that the bigger rate as 1317 is in a former industrial zone. Other former or present industrial area have also a big rate of mortality due to cancer as Camden, more than 800 cases.

All the data was transformed into a shape file, one for the cancer incidence rate and the other for the mortality. Both of them have as common data the zip codes in the city.

The analyses by zip code have great relevance for the Baltimore City and other state organizations concerned with the health control, environment, because all these parameters are related.

Figure 15. Mortality Rate due to cancer , 87 - 96



[10] Jonathan M. Samet and Sarah Adams, "Cancer Incidence and Mortality Patterns in Baltimore City", December 1999- Department of Epidemiology - School of Hygiene and Public Health – JHU, page 1.

4.4. Demographics

The socioeconomic indicators showed substantial numbers of city residents with less than high school education or having household income below the poverty level.

Figure 16. Spatial distribution of white population below the poverty level

This map shows that the percentage of white population (5% of the population) the most affected by poverty is located in the former industrial areas and in the area with a big concentration of brownfields.

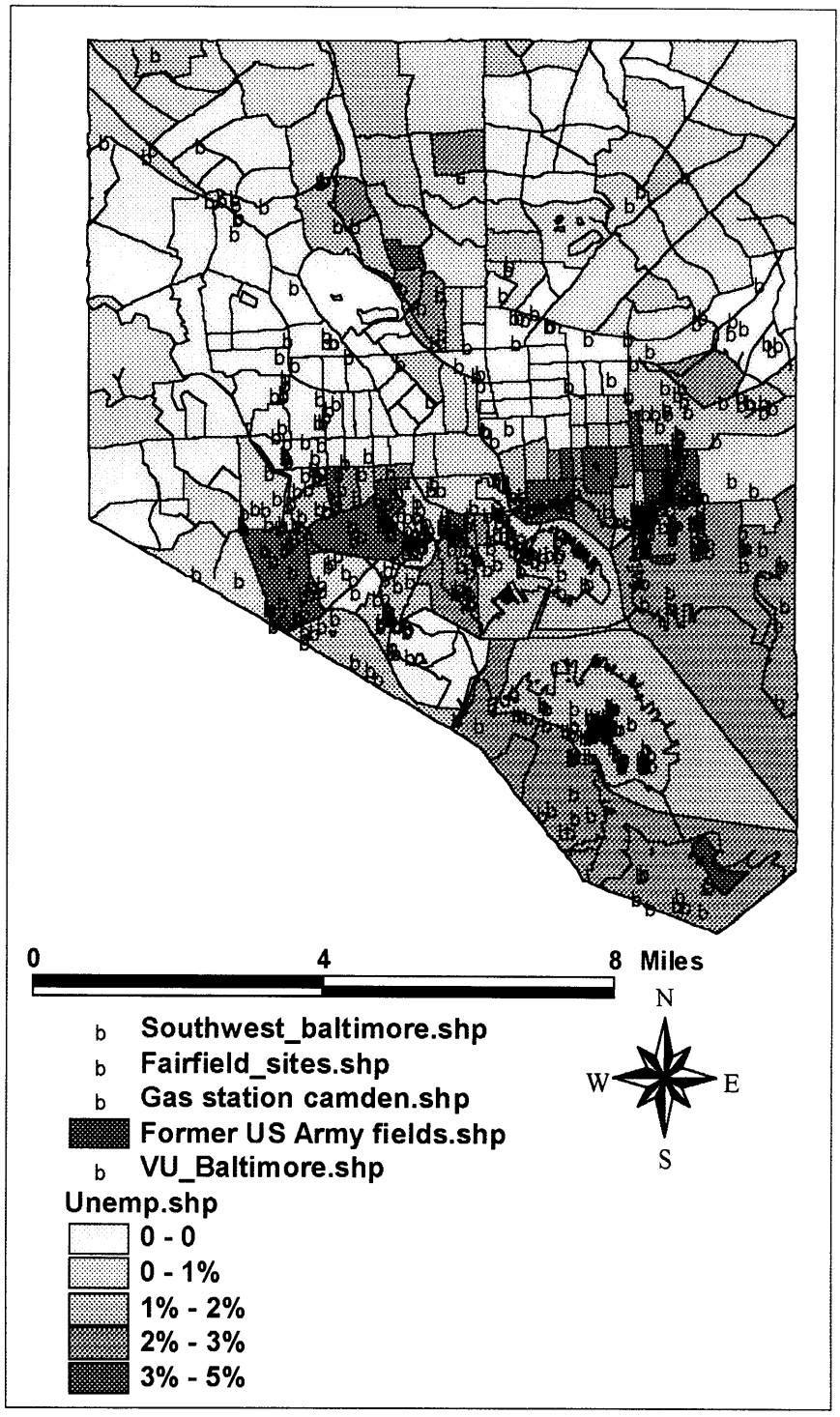


Figure 17. Spatial distribution of Black population below the poverty level

Figure 17 presents the spatial distribution of black population below the poverty level according to census 1990. The biggest rate of black population below the poverty level is not in the former industrial area, except Fairfield, where is not significant. It is not significant because this area is no more populated as before.

The biggest rate is bigger (11%) than for white population (5%).

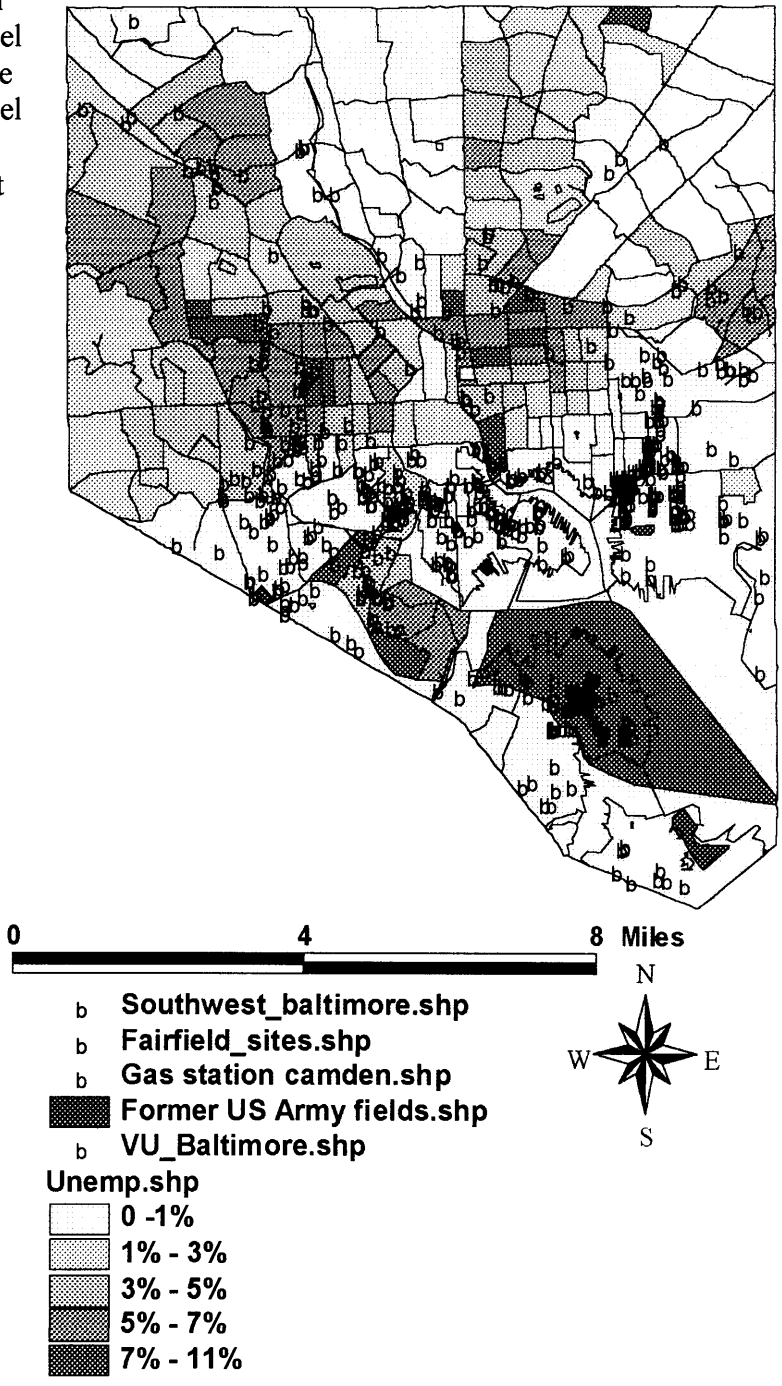
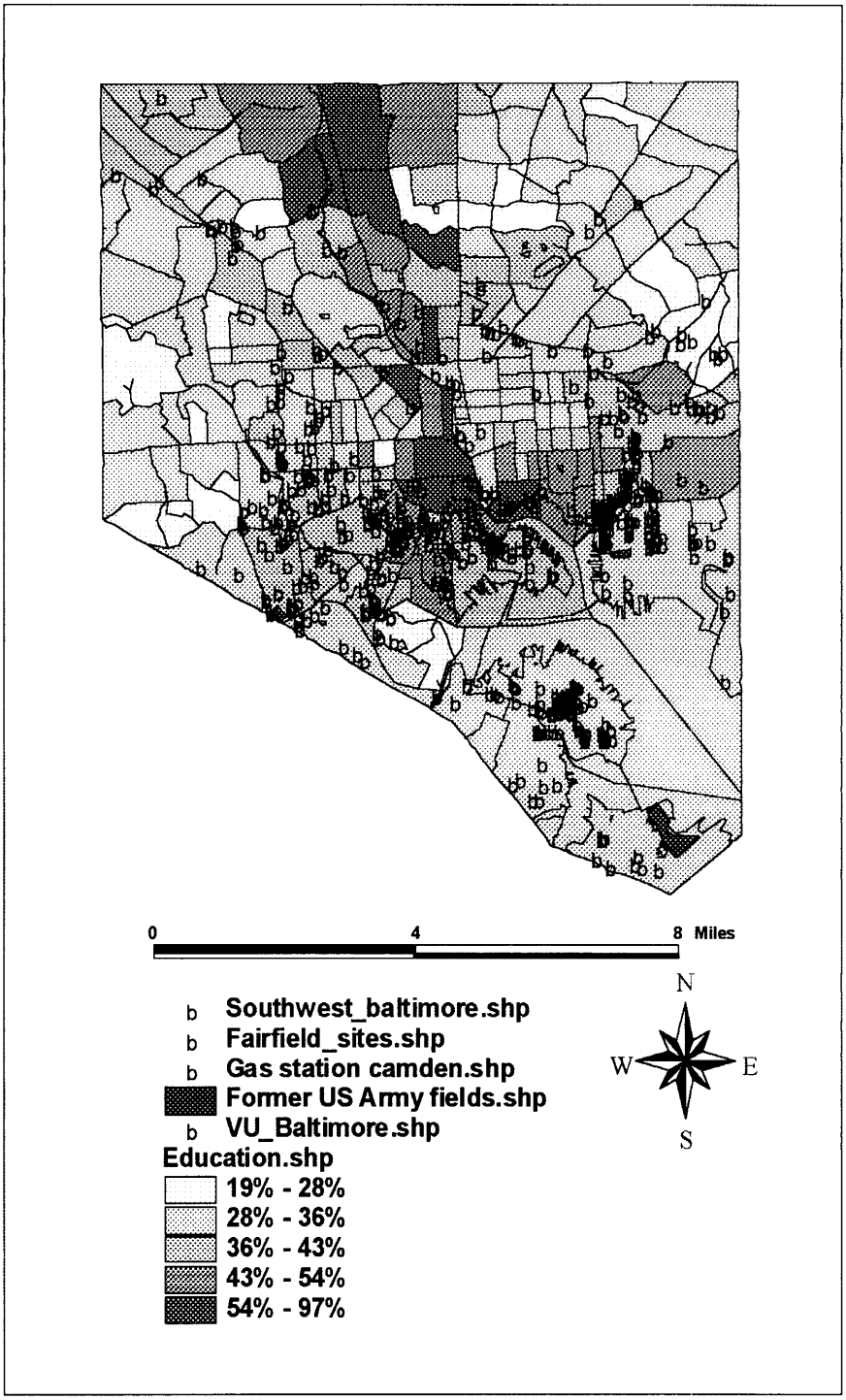


Figure 18. Spatial distribution of population with elementary school

The educational attainment for residents in the poorest areas of Baltimore is lower, between 28 and 54%, than the educational attainment for all residents of Baltimore City. The majority finished the elementary school, spent some years at high school, but did not receive a high school diploma.



CHAPTER 5 - CONCLUSIONS

Brownfields are viewed by many people and agencies as opportunities for revitalizing urban communities. Redevelopment of brownfield sites may reduce health risks, create jobs, provide services, increase local tax revenues, and improve the overall livability of urban neighborhoods. Left undeveloped, however, brownfield areas remain unproductive, generate little or no economic benefits, and are environmentally and socially detrimental to the surrounding communities.

Implications for Setting Brownfield Redevelopment Priorities using GIS

1) Target areas of city where community benefits from brownfields redevelopment are likely to be the greatest based on socioeconomic factors (e.g., Empowerment Zones or Enterprise Communities).

2) Identify potential brownfield sites in those areas. While a **GIS** database updated is a useful tool for accomplishing this step, unavailable data are a potential obstacle. For example, data on site contamination and properties that are abandoned or underutilized may not be readily available or being hidden by the owners.

3) Screen potential brownfield sites based on marketability and availability of suitable end users. This can be done and controlled by the same **GIS** database. Key factors that concern developers include:

-- Extent and level of contamination
-- Regulatory/legal barriers
-- Availability of financing
-- Zoning
-- Land tract size
-- Configuration of existing buildings

4) Evaluate potential community benefits and costs associated with redevelopment of screened sites. These benefits and costs depend on the site location, type and extent of contamination, and land-use, that can be done by **GIS**.

-- Jobs distribution
-- Tax revenues distribution on the area
-- Aesthetic improvements
-- Increased property values
-- Community services
-- Human health impacts

The GIS database built whilst my felowship at Institute for Policy Studies, Johns Hopkins University is a phase 1 for the brownfields redevlopment. It should be developed and used for the phase 2.

The short period of time on this research impedes me to make some several conclusions. The following students or researchers continuing this research maybe will have some conclusions.

In my opinion, a research center should be create to develop this GIS targeting all the related factors: environment, health, socio-economic.

The maps done and database are relevant and I think that "a lot of details" can be changed in the brownfields "arena" in Baltimore City.

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